PATENT SPECIFICATION

655,587

Date of Application and filing Complete Specification Sept. 1, 1948.
Nos. 23075/48 and 23076/48.
Application made in France on Sept. 4, 1947.
Application made in France on Sept. 5, 1947.
Complete Specification Published July 25, 1951.

Index at acceptance:—Classes 51(ii), A23a3; 72, D1a, D5(a2: d1); and 82(i), I4a3x.

COMPLETE SPECIFICATION

A Process for the Smelting of Ores, more especially Iron Ores

We KLOCKNER - HUMBOLDT - DEUTZ, ---organised

PATENTS ACT, 1949

SPECIFICATION NO. 655587

In accordance with the Decision of the Superintending Examiner, acting for the Comptroller-General, dated the second day of May, 1952, this Specification has been amended under Section 29 in the following manner:-

Page 3, line 35, *after* "coke" *delete* "." *insert* ", with separation of the low temperature carbonising gases from the furnace gases."

THE PATENT OFFICE,
16th June, 1952.

DS 21766/2/3243 150 6/52 R

which, therefore, close packing; at the same time it is necessary for the charge to consist of sufficiently large lumps to allow the blast to circulate unrestrictedly and uniformly. In the case of fine-grain ores this requirement can be satisfied by sintering them; as for the fuel it is necessary to use so-called smelting coke, that is fairly large size coke of a rather hard consistency. However, it is known that hard coal suitable for the production of such coke occurs only in few localities, and that there are vast districts in the world where there is no such coal.

This invention offers a solution to the task of smelting even with those fuels which do not yield large-lump, close-grained coke. The invention provides a process for the smelting of ores, more especialy iron ores, wherein the charge comprises fuel and ore, the fuel together with the ore or part of the ore having been compacted in the form of briquettes not exceeding 100 cubic centimetres in volume and preferably of egg-shape, the said charge being smelted in a blast furnace at a stack height from tuyere level [illegible] by means of a

[ ]

of the low height of the charge, the blast furnace can be made correspondingly low and accordingly inexpensive. Furthermore, it is not necessary to convey the charges to the usual height. Finally, the air-blast pressure is considerably lower than has previously been necessary, so that in comparison with the known blast furnace process substantial economy is effected.

A special advantage of the invention is the fact that it is not necessary, as it is with the production of smelting coke, to use highly-processed coal with a maximum ash content of 6 to 8%. In many cases it is even possible to use unprocessed hard coal. Nor is it necessary to do much crushing in preparation for the briquetting. As a matter of fact it is possible to achieve a good composition and binding of the briquettes if the fuel, for example hard coal, has a lump size not exceeding 5 mm. In the case of the ore even coarser grain, viz., not exceeding 10 mm. is

PATENT SPECIFICATION

655,587

Date of Application and filing Complete Specification Sept. 1, 1948.
Nos. 23075/48 and 23076/48.
Application made in France on Sept. 4, 1947.
Application made in France on Sept. 5, 1947.
Complete Specification Published July 25, 1951.

Index at acceptance:—Classes 51(ii), A23a3; 72, D1a, D5(a2: d1); and 82(i), I4a3x.

COMPLETE SPECIFICATION

A Process for the Smelting of Ores, more especially Iron Ores

We, KLOCKNER - HUMBOLDT - DEUTZ, A.G., a German Company, organised according to the laws of Germany, of Koln Deutz, 22c, Germany, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The present invention is concerned with a process for the smelting of ores, more especially iron ores. In present smelting practice shaft furnaces are used which have a height of stack of from 20 to 30 m. This arrangement has been developed with the object of achieving a maximum indirect reduction of the iron oxides and of optimum utilization of the heat of the furnace gases in the reduction and smelting zones. On the other hand the considerable height of the stack is responsible for a very great pressure being exerted on the lower part of the charge which, therefore, is subjected to very close packing; at the same time it is necessary for the charge to consist of sufficiently large lumps to allow the blast to circulate unrestrictedly and uniformly. In the case of fine-grain ores this requirement can be satisfied by sintering them; as for the fuel it is necessary to use so-called smelting coke, that is fairly large size coke of a rather hard consistency. However, it is known that hard coal suitable for the production of such coke occurs only in few localities, and that there are vast districts in the world where there is no such coal.

This invention offers a solution to the task of smelting even with those fuels which do not yield large-lump, close-grained coke. The invention provides a process for the smelting of ores, more especialy iron ores, wherein the charge comprises fuel and ore, the fuel together with the ore or part of the ore having been compacted in the form of briquettes not exceeding 100 cubic centimetres in volume and preferably of egg-shape, the said charge being smelted in a blast furnace at a stack height from tuyere level of 1.5 to 3.5 or 4 metres, by means of a hot-air blast, the said blast furnace having an opposed system of tuyeres the distance apart of any pair of which across the furnace is not greater than 2 metres.

In an advantageous form of the invention the horizontal internal cross-sectional area of the furnace is a rectangle.

As fuel for the present process it is possible to use hard coals not suitable for the production of smelting coke, i.e. grades which do not coke well (coals which bake badly). To these grades belong, for example, the Saar coal, many French coals, more especially the coals from Lorraine.

The invention is based on the realization of the fact that it is possible to perform both low-temperature carbonizing and smelting in a shaft furnace with an unusually low height of stack, the temperature of the furnace gases still keeping within suitable limits. As a consequence of the low height of the charge, the shaft furnace can be made correspondingly low and accordingly inexpensive. Furthermore, it is not necessary to convey the charges to the usual height. Finally, the air-blast pressure is considerably lower than has previously been necessary, so that in comparison with the known blast furnace process substantial economy is effected.

A special advantage of the invention is the fact that it is not necessary, as it is with the production of smelting coke, to use highly-processed coal with a maximum ash content of 6 to 8%. In many cases it is even possible to use unprocessed hard coal. Nor is it necessary to do much crushing in preparation for the briquetting. As a matter of fact it is possible to achieve a good composition and binding of the briquettes if the fuel, for example hard coal, has a lump size not exceeding 5 mm. In the case of the ore even coarser grain, viz., not exceeding 10 mm. is

admissible. It is advantageous to produce the briquettes in egg-shape on roller presses; even when a different shape is chosen it is of advantage to round off the edges and corners and, if required, even the faces of the briquettes.

It is also of importance that with this invention it is possible to use pitch as a binding agent for the briquettes. So far pitch, which is especially suitable for the production of briquettes, has not found any application in smelting shaft furnaces, because the furnace heat softens up the pitch and at an early stage causes the briquettes to adhere to one another. This drawback is obviated by the present process since the low height of the smelting furnace prevents the briquettes from softening readily and from sticking and baking together. The heating of the briquettes is so rapid that a framework of coke is immeidiately formed from the hard coal and the pitch; this makes the briquettes sufficiently firm to remain so until they reach the lower part of the furnace.

Since, according to the invention, hard coal is used not in its low-temperature-carbonized or coked state, the furnace gases contain *inter alia* low-temperature carbonizing vapours or low-temperature carbonizing gases. The low-temperature carbonizing vapours can be removed from the furnace gases whereby low temperature carbonization products are obtained which, as is known, are in great demand.

In many cases it will be of advantage to use as a binding agent instead of, or in conjunction with, pitch or a similar substance containing hydrocarbons, sulphite waste liquor, cellulose pitch or a similar organic water-soluble substance. Sulphite waste liquor has the advantage that it binds well and on heating rapidly forms a coke framework which can stand up to further increased temperatures and ensures the maintenance of a uniform shape of the briquettes.

As a result of the low stack height of the shaft furnace the briquettes introduced into the furnace to heat up very rapidly. This is of outstanding importance especially when badly baking hard coals, which are thus unsuitable for the production of smelting coke, are used. With the heating up taking place quickly, as it does, the low baking power is retained until the hard coal is coked and a solid framework has thus been formed. This applies also to the case where for the production of such briquettes no pitch or a similar substance containing hydrocarbons but only sulphite waste liquor, cellulose pitch or a similar binding agent has been used. Alternatively, water glass or slaked lime can be used as binding agents with advantage.

The efficacy of the new process is due *inter alia* to the uniform shape of each piece of the charge. The smaller and the more uniform the shape is, the better is the reduction achieved. On the other hand, for general practical reasons, one must not go below a certain size; otherwise the hearth would clog easily. The most suitable size of the briquettes is approximately 40 cu. cm. If desired, a part only of the ore may be briquetted, the other part being in piece form of a size approximately equal to that of the briquettes (for example, in roughly cube form with a length of edge of from 35 mm. down to 10 mm.), and charged into the shaft furnace. The briquettes may with advantage be dried until they have a water content of from 1 to 2 per cent. before being introduced into the furnace.

The smelting may be performed with great advantage in a water jacket furnace, which is of a very simple construction and affords great safety of operation. There is no corrosion of the iron water jackets, as the slag formed in the processes of reduction and smelting bakes on to the cooled walls and thus forms a protective layer. The water jacket may cover the whole length of the shaft or it may be provided only locally in the sphere of the reduction and smelting zones. In the latter case the top part of the shaft is made of brickwork.

Reducing and smelting according to the invention are easy to carry out and efficacious in view of the fact that the freshly produced coke is very reactive. This is also responsible for the fact that, unlike the case of blast furnaces, it is often not necessary to preheat the blast. As a matter of fact it is possible to perform the invention with a cold blast.

It is also of advantage to add oxygen to the furnace blast, so-called commercial oxygen having an O_2-content of approximately 95% being chosen for greater economy. As is known the advantage of a blast with a high oxygen content is that it decreases the nitrogen content of the furnace gases whereby their calorific power is raised, making them *inter alia* suitable as starting material for a fuel synthesis according to Fischer-Tropsch. Alternatively, oxygen can be used by itself, but in such a case it is advisable to use non-purified oxygen having an O_2-content of from 80 to 95%. While it is true that the use of oxygen raises the furnace temperature very considerably—which causes, for example in a gas pro-

ducer great waste heat losses—these high temperatures are used in the present process advantageously for the achievement of the second purpose of the process, namely for reducing and smelting the iron. It is therefore, possible to produce in this manner the synthetic gas much more economically than can be done in the gas producer.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A process for the smelting of ores, more especially iron ores, wherein the charge comprises fuel and ore, the fuel together with the ore or part of the ore having been compacted in the form of briquettes not exceeding 100 cubic centimetres in volume and preferably of egg-shape, the said charge being smelted in a blast furnace at a stack height from tuyere level of 1.5 to 3.5 or 4 metres, by means of a hot-air blast, the said blast furnace having an opposed system of tuyeres the distance apart of any pair of which across the furnace is not greater than 2 metres.

2. A process as claimed in claim 1, wherein the horizontal internal cross-sectional area of the furnace is a rectangle.

3. A process as claimed in claim 1 or 2, wherein the fuel used is hard coal unsuitable for the production of smelting coke.

4. A process as claimed in Claim 1, 2 or 3, wherein only part of the ore is briquetted, the other part, being in piece-form of a size approximately equal to that of the briquettes, being charged into the shaft furnace.

5. A process as claimed in any one of Claims 1—4, wherein the agent used for binding the briquettes is pitch or a similar substance containing hydrocarbons.

6. A process as claimed in any one of Claims 1—4, wherein the binding agent used is sulphite waste liquor, water glass or lime by itself or in combination with pitch or with a similar substance containing hydrocarbons.

7. A process as claimed in any one of the preceding claims, wherein instead of the hot-air blast unheated air is used.

8. A process as claimed in any one of the preceding claims, wherein the furnace blast is mixed with oxygen.

9. A process as claimed in any one of Claims 1—7, wherein instead of hot or unheated air commercial oxygen is used.

10. A process as claimed in any one of the preceding claims wherein a water jacket furnace is used.

11. A process as claimed in any one of the preceding claims wherein the briquettes are dried until they have a water-content of from 1 to 2% before being introduced into the furnace.

Dated this 1st day of September, 1948.

ABEL & IMRAY,
Agents for the Applicants,
Quality House, Quality Court,
Chancery Lane, London, W.C.2.